



IR-1609 (2-1941)

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF APPEALS AND INTERFERENCES**

In re Patent Application of:

New York, New York

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For: P-CHANNEL TRENCH MOSFET STRUCTURE

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REPLY BRIEF PURSUANT TO 37 CFR §1.193(b)(1)

Sir:

This Reply Brief is submitted to the Examiner's Answer dated July 25, 2003. In particular, Applicant seeks to clarify particular issues discussed in the Examiner's Answer.

In Paragraph 10 the Examiner states in the Grounds of Rejection that claims 1, 3-6, 8-13 and 20-22 are rejected over Floyd et al. (U.S. Patent No. 6,090,716; the Floyd '716 patent). Claims 4-6, 8-13 and 21-22 recite a P-type substrate and a drain contact connected to the substrate. The drain contact is formed of metal, for example, as recited in the specification on page 10, lines 15-18.

The disclosure by Floyd '716 shows a layer of polysilicon on a bottom surface of the disclosed device, thereby producing a different structure than that recited in the above-mentioned claims. Indeed, due to the polysilicon layer, it is unclear whether the device by Floyd '716 is a vertical conduction MOSFET or bidirectional, as is the present invention. Due to the differences in structure, the present invention recited in the above-mentioned claims should not be considered obvious in view of the structure disclosed by Floyd '716.

The disclosure by Floyd '716 also fails to show a source contact connected to the epitaxially deposited layer, as is recited in claims 10, 11 and 13. The source contact connected to the epitaxially deposited layer creates a significantly different device with significantly different characteristics, and not bidirectional. Accordingly, claims 10, 11 and 13 should not be considered obvious in view of the different structure and type of device disclosed by Floyd '716.

The Examiner further notes on page 5 of the Answer that "the MOSFET device of Floyd with reversed polarity would inherently have a reduced ON resistance," referring to claims 4-6, 8-13 and 21-22. Applicant submits in response that the structure described by Floyd '716 includes a polysilicon layer on a bottom surface that has a thickness of approximately 1500Å, which if included in the vertical conduction MOSFET device of the present invention would make the present invention inoperative, or at least unable to accomplish the purpose for which it was designed. If the device by Floyd '716 were reversed in polarity, Applicant submits that the polysilicon layer on the bottom of the device would prevent the resulting device from having an inherently reduced ON resistance. Indeed, the bottom polysilicon layer of Floyd '716 appears to lack any doping.

In addition, Applicant submits that it would not be obvious to reverse the polarity of the device in Floyd '716 to arrive at the present invention, and that the Examiner uses an incorrect standard to reach a conclusion of obviousness, as described in greater detail below. Furthermore, merely reversing the polarity of the device disclosed by Floyd '716 would not inherently result in a reduced ON resistance in comparison with prior P-channel devices due to the differences in doping concentrations, dimensions and processes involved in constructing the different polarity devices, notwithstanding the presence of the bottom polysilicon layer. A simple reversal of polarity of the device disclosed by Floyd '716 would produce a device with much greater ON resistance than that of the present invention, unless a number of changes were made and precautions were taken, as explained and described in the claims and specification of the present invention, as well as illustrated in the declaration by Ritu Sodhi. Moreover, the Examiner has not provided any evidence to support the assertion made in the Answer related to reduced ON resistance, which would be necessary to establish a *prima facie* case of obviousness.

The Examiner also states on pages 5-6 that it is obvious to obtain a channel layer with a resistivity of about 0.17ohm-centimeters and a thickness of about 2.5 micrometers, with a substrate that has a resistivity of less than about 0.0005 ohm-centimeters, referring to claims 8 and 11-13. However, the Examiner has not supplied any evidence to support this assertion, and in particular has not supplied any evidence with respect to P-channel type power MOSFET devices. Applicant has supplied ample evidence of the advantages of the selection of particular parameters and submits that P-type power MOSFET devices have previously not been as popular because of the disadvantage of higher ON resistance in comparison with their N-channel counterparts. Because of the selection of resistivity and thickness of the channel layer, and the resistivity of the substrate, the present invention recited in claims 8 and 11-13 overcomes the disadvantages of the prior art P-channel power MOSFETs, while maintaining the simplicity of control for a P-channel MOSFET. Accordingly, claims 8 and 11-13 should be allowable in the absence of evidence to the contrary that the recited parameters and ranges are well known to one of ordinary skill in the art, or that the advantages obtained by the present invention are well known.

On page 6 of the Answer, the Examiner states that it is well known in the art to have a source electrode in direct contact with the heavily doped source region a channel forming layer, citing Figure 12 of Floyd '043 and Figures 1, 2 and 4 of Darwish '766. Applicant notes that none of these disclosures teach or suggest a source contact connected to the epitaxially deposited layer forming the channel of the device, as recited in claims 6, 10-11 and 13. Accordingly, Applicant submits that claims 6, 10-11 and 13 should be allowable as containing a limitation not taught or suggested in the cited prior art, or any combination thereof.

In Paragraph 11 of the answer, the Examiner responds to Applicant's arguments against obviousness. In response to Applicant's claims of unexpected results and advantages, the Examiner states on pages 7-9, that "there is no evidence to show that the P-channel MOSFET of the instant invention has achieved an ON resistance lower than that of the N-channel MOSFET of Floyd '716." In making this statement, the Examiner has apparently misconstrued both the invention recited in claims 1, 3-6, 8-13 and 20-22 and evidence provided by Applicant in support

of unexpected results and advantages in the present invention. Applicant has provided arguments against a finding of obviousness by illustrating that one of ordinary skill would not be led to reverse the polarity of the device by Floyd '716 to arrive at the present invention. Yet, even if an artisan reversed the polarity of the Floyd '716 device, the results would not be nearly as advantageous as those Applicant has achieved, as discussed above. Accordingly, not only would it be non-obvious to reverse the polarity of the Floyd '716 device, the expected results of such a reversal would be poor in comparison with the advantages of the present invention. The fact that Applicant has achieved results that would not otherwise be expected further supports Applicant's argument against the obviousness of a polarity reversal of the Floyd '716 device.

Applicant has maintained the position that the reversal of the polarity of the device disclosed by Floyd '716 would not be obvious to one of ordinary skill in the art, even given the knowledge that construction of a complementary polarity device may be possible. A general incentive does not make obvious a particular result. In re Deuel, 51 F3d 1552, 34 USPQ2d 1210 (Fed. Cir. 1995). The fact that a claimed invention may be well within the capabilities of one of ordinary skill in the art is not sufficient by itself to establish *prima facie* obviousness. In re Kotzab, 217 F3d 1365, 1371, 55 USPQ2d 1313, 1318 (Fed. Cir. 2000); MPEP 2143.01. The Examiner states in rejecting claims 1, 3-6, 8-13 and 20-22 over Floyd '716 that, "it would have been well within the ordinary skilled[sic] in the art at the time the invention was made to make the MOSFET device of Floyd with the dopant polarity being reversed," which is an insufficient conclusion to establish a *prima facie* case of obviousness. In addition, the disclosure by Floyd '716 calls for a 1500Å thick layer of polysilicon on the bottom of the MOSFET device, which if included in the device of the present invention, would make the P-channel MOSFET of the present invention unworkable. Also, Applicant submits that if the n-channel MOSFET by Floyd '716 were reversed in polarity, it would no longer attain the advantages and characteristics associated with an n-channel MOSFET, thereby rendering the prior art invention unsatisfactory for its intended purpose. Applicant therefore submits that there is no suggestion or motivation to reverse the polarity of the device by Floyd '716. In re Gordon, 733 F2d 900, 221 USPQ 1125 (Fed. Cir. 1984); MPEP 2143.01. Applicant further submits that

all the claim limitations recited in claims 1, 3-6, 8-13 and 20-22 are not taught or suggested in any of the cited prior art references. MPEP 2143.03.

Applicant further submits that the Examiner's conclusion of obviousness of the present invention based on a reversal of polarity of the device disclosed by Floyd '716 amounts to application of the inappropriate "obvious to try" test for obviousness. That is, even though the Examiner states that the present invention is within the ordinary skill, such a conclusion, even taken as true, does not support *prima facie* obviousness. Instead, Applicant submits that the Examiner, upon being exposed to the concept of the present invention, found a reference with some similar characteristics, and then made the mental leap to say that one of ordinary skill in the art exposed to Floyd '716 would naturally obtain the present invention. This "obvious to try" test is not a legitimate standard of patentability. In re Geiger, 815 F2d 868,688, 2 USPQ2d 1276, 1278 (Fed. Cir. 1987). Alternately, Applicant submits that the Examiner has engaged in hindsight to reach a conclusion of obviousness because it is only through being exposed to the teachings of Applicant's invention that the Examiner draws on the disclosure by Floyd '716 to reach a conclusion of obviousness. That is, except for Applicant's disclosure, the Examiner could not have reached a conclusion that the P-channel MOSFET of the present invention would be obvious in view of the disclosure by Floyd '716. To suggest that one of ordinary skill in the art has knowledge of the invention when no prior art reference or references of record convey or suggest that knowledge is to engage in hindsight reasoning where that which the inventor taught is used against the inventor. W.L. Gore v. Garlock, Inc., 721 F2d 1540, 1553, 220 USPQ 303, 313 (Fed. Cir. 1983).

Indeed, Applicant has produced unexpected results and advantages over the prior art P-channel MOSFET described in the application in further support of non-obviousness. Applicant has not only been able to achieve a P-channel MOSFET device without a drift region, but has also provided a constant concentration epitaxial layer through which the channel is established. Applicant has also provided a channel layer that is thinned and reduced in dopant concentration to obtain a low threshold voltage while decreasing ON resistance (see page 7 of the specification). These advantages are recited in at least claims 8 and 11. The combination of

constant concentration epitaxial layer, the concentration amount and the depth of the epitaxial layer all combine to produce a reduced threshold voltage with lowered ON resistance for a P-channel device. Clearly, these are advantages that are not taught in any of the cited prior art references. The fact that the P-channel MOSFET according to the present invention has a reduction in ON resistance and threshold voltage and a power loss decrease of up to a factor of four times that of the prior art P-channel device should be clear evidence of unexpected results and advantages obtained by the present invention.

Applicant also notes that no other P-channel devices similar to that of the present invention have been found or cited by the Examiner. The Examiner bases the rejection of the claims on the notion that one of ordinary skill in the art would readily obtain the P-channel according to the present invention by modifying other structures disclosed in the cited references. Applicant has pointed out the tremendous advantages of the present invention, noting the reduced ON resistance, reduced threshold voltage and desired simplicity of using a P-channel power MOSFET that requires less circuitry than that of an N-channel type device, and therefore provides reduced circuit component count and simplicity of design. If it was true that one of ordinary skill in the art would construct the P-channel MOSFET according to the present invention based on prior art P-channel devices or N-channel devices, as the Examiner asserts, there should be a number of references available to show the device, given all the advantages described above. However, the Examiner has presented no publications or documents that show the advantageous P-channel MOSFET of the present invention. Accordingly, Applicant questions the finding of obviousness by the Examiner when no description of a device similar to that of the present invention exists, even in a mature industry in a very crowded field of art.

Beginning on page 9 of the Answer, the Examiner states that the prior art references of Floyd '043 and Darwish et al. sufficiently demonstrate the routine experimentation of reverse polarity design. However, Floyd '043 only suggests that the complementary device may be constructed, and provides no details on constraints or limitations on the actual construction of such a device. In addition, Applicant notes that the device in Floyd '043 is a depletion mode FET which has very different characteristics than the enhancement mode

MOSFET of the present invention, and therefore cannot be expected to react in the same manner when the polarity is reversed. That is, even if Floyd '043 can be said to reliably show a complementary device that works appropriately, the same inference cannot be extended to the enhancement mode MOSFET of the present invention, simply because it is a different device with a different mode and theory of operation.

Similarly, the disclosure by Darwish et al. merely states that the principles of the invention are applicable to both N-channel and P-channel MOSFETs. Darwish et al. fail to describe or discuss any other challenges with regard to reversing the polarity of N-channel MOSFETs to achieve a P-channel MOSFET. Accordingly, while both Floyd '043 and Darwish et al. appear to recognize that complementary devices may be possible, there is absolutely no discussion or teaching as to how to arrive at a complementary device from a given polarity.

The Examiner also states that the values for resistivity and layer thickness are subject to routine experimentation and optimization, citing In re Aller, 220 F2d 454, 456, 105 USPQ 233, 235 (CCPA 1955) (“[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.”). However, the Examiner has not demonstrated that the conditions of the claims in the application are taught or suggested in any of the cited prior art references. Accordingly, Applicant submits that the resistivity and thickness recited in the claims of the present application should not be considered obvious because of a lack of discussion in the cited prior art and a lack of evidence supplied by the Examiner. Indeed, the CCPA recognized that there are exceptions to the rule set forth in In re Aller when the results of optimizing a result effective variable were unexpectedly good. In re Antonie, 559 F2d 618, 195 USPQ 6 (CCPA 1977) (citing in re Waymouth, 499 F2d 1273, 182 USPQ 290 (CCPA 1974); In re Saether, 492 F2d 849, 181 USPQ 36 (CCPA 1974)). Accordingly, Applicant believes that the position stated by the Examiner with respect to claims 8 and 11-13 is unsupported by any evidence or the relevant case law cited by the Examiner.

The Examiner also states on page 11 of the Answer that with respect to claims of commercial success, an evaluation of objective evidence of success must be made, along with a

determination of whether the success can be attributed to ornamental design. However, this is not the correct standard to apply with respect to evidence of commercial success. A nexus between commercial success and the claimed features must be shown. Brown and Williamson Tobacco Corp. v. Philip Morris Inc., 229 F3d 1120, 56 USPQ2d 1456 (Fed. Cir. 2000). If the marketed product embodies the claimed features and is coextensive with those features, a nexus is presumed and the burden shifts to the Examiner to rebut the presumed nexus. *Id.*, citing J.T. Eton & Company v. Atlantic Paste and Glue Company, 106 F3d 1563, 1571, 41 USPQ2d 1641, 1647 (Fed. Cir. 1997). The presumed nexus cannot be rebutted with argument but only with further evidence of obviousness. In the present application, Applicant has demonstrated significant commercial success with devices constructed according to the claims of the present invention. The Examiner has provided no evidence to rebut the nexus between the commercial success and the claimed features of the invention. Instead, the Examiner focuses on the ornamental design of the invention, citing case law for design patents. However, Applicant has not claimed an ornamental design. Accordingly, the evidence of substantial commercial success should be given due weight to find that the claimed invention is not obvious.

The Examiner also states on pages 12-14 of the Answer that the N-channel MOSFET of Floyd '716, with the polarity reversed to produce a P-channel MOSFET, would naturally have a reduced ON resistance when compared to a conventional P-channel MOSFET. However, Floyd '716 teaches an undoped bottom polysilicon layer that would increase ON resistance in a vertical MOSFET. Indeed, the Examiner has produced no evidence for the stated conclusion, which would be required to form a *prima facie* case of obviousness. In addition, the Examiner states that a P-channel MOSFET made by reversing the polarity of the N-channel MOSFET by Floyd '716 would be fully and directly readable on the MOSFET defined in the claims of the present application. This statement is incorrect, as discussed above, because the device by Floyd '716 includes a polysilicon layer on the bottom of the device, and does not show a connection between a source contact and the epitaxial layer, thereby disclosing substantially different structures than those recited in the claims.

The Examiner states in the Answer that "holes in silicon would have lower mobility than electrons", confirming that the P-channel MOSFET would naturally have a higher ON resistance than an N-channel device because of the direct correlation between carrier mobility and ON resistance in semiconductors. Thus, with respect to obviousness, one of ordinary skill would not be motivated to arrive at the present invention based on the disclosure by Floyd '716, because of the higher mobility of carriers and attendant lower ON resistance disclosed in the device by Floyd '716, and the opposite characteristics attained in a P-channel device.

Based on the above discussion and evidence of record, Applicant believes that a proper case of obviousness has not been established against the present invention recited in claims 1, 3-6, 8-13 and 20-22. Indeed, Applicant believes that ample evidence and case law support has been presented that establish that the present invention is non-obvious. Applicant therefore respectfully requests that the rejections of record against the claims in the present application be reversed.

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January 21, 2004

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Respectfully submitted,


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